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Tadevosyan, Ruzanna

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Kontakt/Contact

ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics
Düsternbrooker Weg 120
24105 Kiel (Germany)
E-Mail: [rights\[at\]zbw.eu](mailto:rights[at]zbw.eu)
<https://www.zbw.eu/econis-archiv/>

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Ruzanna Tadevosyan,

Armenian State University of Economics, Republic of Armenia

 ORCID ID, 0000-0003-2226-6435

email: rtadevosyan.amberd@asue.am

CORE DETERMINANTS OF COMPANIES INNOVATION PERFORMANCE: CASE FOR ARMENIA

Abstract. *The paper discusses scientific arguments and counterarguments about companies' innovative activity, size, and geographic location of the sales market. The study's foremost purpose is to empirically check if theoretical statements about a company's size, export, and innovative activity are associated. Therefore, the questions discussed in this paper are a) Does an enterprise-size matter an enterprise innovation activity? b) Is there a difference in innovation activity by Classification of Economic Activities (NACE groups)? c) Does the geographic location of the sales market matter the company's innovation activity? The research questions are discussed based on Armenian firm-level data. The findings could be applied mainly to the microeconomic environment of Armenia. The study involved R programming language Wilcoxon test, ANOVA, Tukey test, and Chi-square test are applied. The obtained results showed that the enterprise's size does not matter an enterprise's innovative activity. Even though larger companies have more resources to innovate, smaller companies are more flexible and agile. Therefore, the enterprise size is not a limiting factor. The results showed that the companies in some fields of the economy are more prone to innovate than others. In Armenia, most innovative enterprises operate in the group M-Professional, scientific and technical activities and the group C-Manufacturing. The research empirically confirms that when considering a company's innovative activity, the sphere of the economy in which it operates has statistically significant importance in contrast with the company's size. The findings by the Chi-Square test showed that a significantly higher number of EU exporting companies had made innovations. In contrast, companies selling their products/services in the local market have made significantly fewer innovations than expected if there would be no association between innovations and the geographic location of the sales market. Therefore, the exporting companies are more innovative than those that sell their products in the local market. Besides, the most innovative firms are EU exporting enterprises. In empiric studies, export is used as a proxy of international competitiveness due to its ability to show a country's capacity in producing and selling in the international market. Therefore, the analysis of Armenian firm-level data showed the association between innovation and international competitiveness.*

Keywords: competitiveness, enterprise activity, enterprise size, export, innovation.

Introduction. The scientific background showed a connection between innovation, international competitiveness, and economic growth. Besides, innovation requires huge financial and human resources. Therefore, doing innovations is mostly considered the «monopoly» of large and medium-sized enterprises. Hence the main purpose of this study is to check empirically if these theoretical statements are true in practice. The research questions are as follows a) Does an enterprise-size matter an enterprise innovation activity?; b) Is there is a difference in innovation activity by Classification of Economic Activities (NACE groups)?; c) Does the geographic location of the sales market matter the company's innovation activity? The research questions are discussed based on Armenian enterprises' level data. Therefore, the results are mainly applicable to the microeconomic environment of Armenia. As there is only one year of cross-sectional data, the analysis has been performed based on the data's availability, and the methods are chosen considering this restriction. For analyzing data, quantitative methods were used: Wilcoxon test – for the first question; analysis of Variance – for the second question; Chi-Square test – for the last question. It is essential to study small and medium-sized enterprises' (SMEs) innovation performance as SMEs are the mainstay of any economy. They present 99% of all businesses in the EU (European Commission, 2020). In 2019, 70045 out of 70180 companies operating in the Republic of Armenia were SMEs, which was 99.8% of the companies (ARMSTAT, 2020). The value-added produced by SMEs amounted to 24% of the RA GDP. According to economist Michael

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Porter, one of the world's most influential thinkers on management and competitiveness, national competitiveness depends on the ability of specific industries and industry segments to innovate and upgrade (Porter, 1990). There are the companies the enterprises competing internationally. Their competitiveness determines the entire competitiveness of the country.

Literature review. Innovation as a driving force for economic growth has changed over time. In addition to new technologies, innovation includes non-technological areas. Still, earlier in the 20th century, J. Schumpeter presented innovation as a dynamic process in which new technologies replace old ones, resulting in «Creative destruction» (Schumpeter, 2010). According to Schumpeter, development is conditioned by innovation (new combinations). In 1992, the OECD published the Oslo Manual-Proposed Guidelines for Collecting and Interpreting Technological Innovations (an internationally accepted guide to measuring innovation performance) emphasized the technological aspect of innovation, which included new products, new processes, and significant changes (Shavnina, 2003). That is why innovation is often associated with the IT industry, and countries develop their innovation policy, focusing mainly on that sector. The UN Economic Commission study stated that a narrow understanding of innovation prevails in Armenia based on technology-focused innovation (United Nations, 2014). While innovation is a broader concept than just technological innovation is. Moreover, it is an even broader concept than research and experimental development (R&D). As stated in the Frascati manual, it comprises creative and systematic work undertaken to increase the stock of knowledge, including the knowledge of humankind, culture, society, and diverse new applications of available knowledge (OECD, 2015). Therefore, innovation is a more comprehensive concept than R&D. If the uses of technologies developed by other organizations in their own organization, the production of new products developed by other organizations are left out in R&D, then these are fully included in innovations. It is enough for the organization to be new here. It does not have to be new in the market.

By the time Oslo's second edition was published in 1997, the scope of the innovation survey had expanded to include not only the industry but also construction, utilities, and other services (OECD, 1997). However, the technological aspect of innovation was still preserved and was more emphasized. The technological aspect of innovation in the world was maintained until 2005 when the third edition of Oslo was published. It expanded the definition of innovation, introducing non-technological innovation. According to the definition in the third edition of the Oslo Manual, innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations (OECD, 2005). Oslo's latest edition, 2018, has again reduced the types of innovation, separating only product and process innovation. Nevertheless, it has not narrowed its boundaries. Moreover, due to the general definition, it has become applicable to business and other sectors of the economy, such as the government, households, and non-commercial households (OECD, 2018).

The concepts and definitions used in the Report on Pilot Survey of Innovation Activity of Legal Entities and Entrepreneurs of the Republic of Armenia are based on Oslo's third edition. The data in this study is also taken from that report. Exploiting similar local microdata, the Australian researcher Palangkaraya (2012) has investigated the connection between innovation activity and companies' export behavior. By applying the propensity score matching method. The investigation has found a positive correlation between them. The paper has also found a reciprocal causal relationship in process innovation, particularly in the services sector. Product innovation has revealed that product innovators have a higher probability of becoming new exports in the same current period. The investigation found sturdy evidence that the connection between innovation and export depends on the companies' industry.

Contrarily, the results of K. Wakelin's research back in 1998 show a sharp contrast. Using a microeconomic dataset of UK firms and applying a dummy variable approach, the paper has considered the role of innovation in determining export behavior for a sample of UK firms, including innovating and

non-innovating companies. The outcomes show that the determinants are different between innovative and non-innovative firms. And non-innovative firms are more likely to export than innovative firms. In other words, innovative companies sell their products at the local market. At the same time, the research also finds that the amount of past innovations positively impacts the probability of an innovative firm exporting. It could mean that innovative activity positively affects the propensity to export with some lags difference (Wakelin, 1998). In other words, innovation effects on export and its influence are positive, but some time is needed for that impact. Damijan et al. (2008) considered Slovenian firm-level data to investigate the relationship between innovation and export. By applying the bivariate probit regression model, which relates the probability of exporting in period t to lagged firm characteristics, they found a positive relationship between innovation and export. Paper finds that the causality between the two may run in both directions. It suggests that product innovation may play a crucial role in the decision to export, while successful innovation may run itself to process innovation. The paper found evidence that export leads to productivity improvements. Still, it did not find any statistically significant evidence that product or process innovation could raise the probability of becoming a first-time exporter. Thus, based on the paper's obtained results, neither relationship could be interpreted as causal.

Lachenmaier and Woessmann (2006) tested whether innovation causes exports among German manufacturing firms. Their empirical strategy detects differences in an innovative activity resulting from specific impulses and obstacles that they encounter in their pathway. The authors consider these factors as exogenous to companies' export performance. The research finds that innovation stemming from the differences of these factors on average leads roughly to 7 percentage points greater export proportion in a company's total revenue. Besides, based on unconditional difference descriptive, innovators point to a greater export proportion (on average 12.6%) than non-innovators. It is primarily because of innovations' causal effect on export. Notably, only a smaller proportion emerges from the reverse causation. Thus, in the case of German entities and enterprises, the empirical investigation has shown that companies that innovate have a greater export proportion in their total revenue than the others which do not innovate. Moreover, the empirical investigation has shown that being innovative causes firms to have substantially larger export shares than non-innovative firms in the same sector. Thus, the results of this research backing the forecast of the product-cycle models and proving that innovation is a crucial factor for industrialized countries' exports.

Methodology and research methods. All the other data used in this study was taken from the «Report on Pilot Survey of Innovation Activity of Legal Entities and Enterprises» made by the National Statistic Service of the Republic of Armenia. Wilcoxon test was conducted for the first question «Does an enterprise size matter an enterprise's innovation activity?». The results are presented in the next part. The Wilcoxon Rank Sum Test is often described as the non-parametric version of the two-sample t-test (Hogg et al., 1977). The null hypothesis of the Wilcoxon test is that the two populations have the same distribution with the same median.

H0: Small enterprises' innovative activity median=Medium and Large enterprises' innovative activity median.

H1: Small enterprises' innovative activity median \neq Medium and Large enterprises' innovative activity median.

To find if there is a difference in innovation activity in different NACE groups. A one-way ANOVA test was undertaken for analysis of variance (ANOVA, using an F-test) performs a hypothesis test comparing the variances (Cuevas et al., 2004). ANOVA is a vital tool for conducting studies on several experimental groups and one or more control groups. Suppose the F value is larger than the means of the groups. In that case, groups are significantly different from each other compared to the variation of the individual observations in each group. A larger F value than the critical value is interpreted as the differences between group means are larger than what would be expected by chance.

H0: All groups' number of innovative enterprises' means are the same.

H1: Not all groups' number of innovative enterprises' means are the same.

The Chi-Square test is undertaken for the last question, which tends to prove innovation positively influences international competitiveness. The Chi-square statistic is a non-parametric (distribution-free) tool intended to evaluate group differences when the dependent variable is measured at a nominal level (McHugh, 2013). Similar to all non-parametric statistics, the Chi-square allows analyzing even when the sample sizes of the study groups are unequal, which usually happens with the data gathered from the surveys. It also does not necessitate equality of variances among the study groups or homoscedasticity in the data. The chi-square test is the most common test to investigate if the observed counts differ significantly from the expected counts. The Chi-Square test for associations is applied when there is not already known expected frequency, which is in this case.

All these tests and counts are done by using the R statistical program.

Results. «Does an enterprise size matter an enterprise innovation activity?». The share of innovative enterprises in different NACE groups' t-test or alternative non-parametric tests should be applied to test the difference.

Table 1. Share of innovative enterprises in the total number of enterprises by NACE Rev.2 and size of enterprises

NACE group	Small	Large and Medium	NACE group	Small	Large and Medium
A	9,6	20	I	9,6	4,3
B	17,8	9,1	J	6,1	29,4
C	10,9	24,5	L	5,4	14,3
F	3,1	3,9	M	26,8	13,6
G	6,6	14,1	N	1,1	4,3
H	2,2	9,4			

Sources: developed by the author based on (ARMSTAT, 2017).

To choose an appropriate test, firstly, data distribution needed to be checked – is it normally distributed or not. Shapiro-Wilk test has been applied, which results are $w=0.0964$ and $p\text{-value}=0.039$. The p-value is less than 0.05. Therefore, the null hypothesis that the data is normally distributed at $\alpha=0.05$ is rejected. As the data is not normally distributed Wilcoxon rank-sum test is the best in this situation.

Table2. Wilcoxon test results

w	p-value
0.0964	0.039

Sources: developed by the author using R programming language.

The outcomes of the Wilcoxon test are $w=79$, $p\text{-value}=0.237$. Since the p-value is greater than 0.05 the null hypothesis rejection is failed at $\alpha=0.05$, which means that these two distributions do not differ significantly – they do not have different medians (Ford, 2017). Thus, the conclusion is that firm size does not matter when considering innovation activity, or the size is not a limiting factor. It is supposed that larger companies have more resources. Therefore, they tend to be more innovative. But the results show that it is not a statistically significant factor which can have many reasons. It could be because small companies are more agile and flexible than larger ones. And a company's age and the field where the company operates matters more. The latter is discussed in the next question.

For answering the question «Is there a difference in innovation activity in different NACE groups» the ANOVA test has been applied based on table 3 data.

Table 3. Number of innovation enterprises in different NACE groups

NACE group	Innovative companies	NACE group	Innovative companies
B	3	G	1
B	1	G	3
B	4	H	5
C	12	H	6
C	66	H	1
C	40	H	1
C	13	J	13
D	18	J	6
D	1	J	6
D	1	J	7
D	0	M	24
G	1	M	14
G	56	M	9
G	31	M	20

Sources: developed by the author based on (ARMSTAT, 2017).

But before interpretation, diagnostic plots have been plotted to check normality and homoscedasticity.

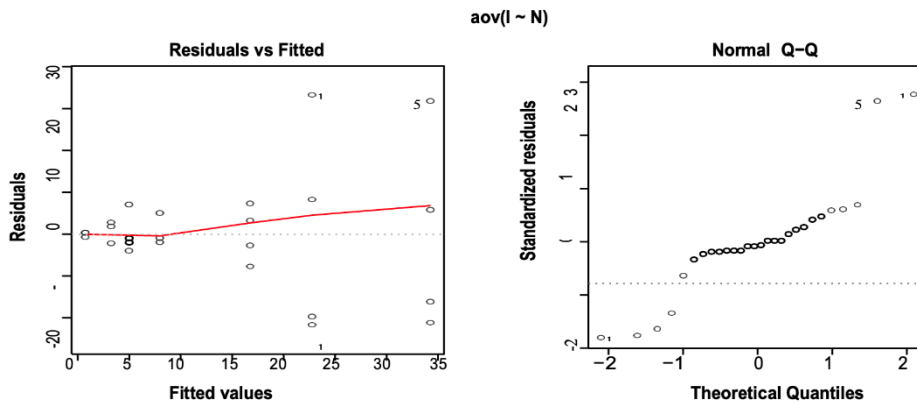


Figure 1. Diagnostic plots of Innovative enterprises and NACE groups

Sources: developed by the author using R programming language.

Diagnostic plots depict that the data have some problems. Particularly Residuals vs. Fitted values graph shows that the spread of residuals of groups six and seven are three times more than the spread of residuals of groups one, two, three, and four. Besides, the QQ plot shows that observations number 13, number 15, and 5 are a little bit far from the line. So, firstly data transformation is needed, and then again, it will be check via diagnostic plots. After doing square root transformation and checking it via diagnostic plots, the picture has changed. Particularly residuals have equal spread. QQ plot also improved. So, it can be considered normal. Therefore, the analysis will be done on that squared transformation model.

Table 4. ANOVA results

Indicatore	Df	Sum sq	Mean sq	F value	p-value
N	6	65.40	10.900	4.557	0.00414
Residuals	21	50.23	2.392		

Sources: developed by the author using R programing language.

Since p-value <0.05, H0 is rejected 0.05 with the conclusion that at least two groups number of innovative enterprises means are different. To understand which groups' means are different, Tukey test was applied.

Table 5. Tukey test results

Parameters	Estimate	Lower interval	Upper interval
C - B = 0	3.52516	-0.02980	7.08012
D - B = 0	-1.29904	-4.85400	2.25592
G - B = 0	1.89674	-1.65822	5.45171
H - B = 0	-0.37765	-3.93261	3.17731
J - B = 0	0.73853	-2.81643	4.29349
M - B = 0	1.97916	-1.57581	5.53412
D - C = 0	-4.82420	-8.37916	-1.26924
G - C = 0	-1.62841	-5.18337	1.92655
H - C = 0	-3.90281	-7.45777	-0.34785
J - C = 0	-2.78663	-6.34159	0.76834
M - C = 0	-1.54600	-5.10096	2.00896
G - D = 0	3.19578	-0.35918	6.75074
H - D = 0	0.92139	-2.63357	4.47635
J - D = 0	2.03757	-1.51739	5.59253
M - D = 0	3.27819	-0.27677	6.83315
H - G = 0	-2.27439	-5.82935	1.28057
J - G = 0	-1.15821	-4.71317	2.39675
M - G = 0	0.08241	-3.47255	3.63737
J - H = 0	1.11618	-2.43878	4.67114
M - H = 0	2.35680	-1.19816	5.91176
M - J = 0	1.24062	-2.31434	4.79558

Sources: developed by the author using R programing language.

It is clear from Tukey test results that only the intervals H and C, D and C do not contain 0. Therefore the conclusion is that except for these three groups, all the others have different means. It means that the field in which a company operates really matters. The enterprises in some fields of the economy are more prone to innovate than others. The most innovative Armenian enterprises are included in group M (Professional, scientific and technical activities), group C (Manufacturing), and group B (mining and quiring). The last question which is discussed in this study is «Does sales market geographic location matters a company's innovation activity is considered?»

Since P-value is less than 0.05, the null hypothesis was rejected: sales geographic market and innovation activity are independent. Thus, there is an association between sales geographic market and innovation activity. Table 8 shows that the largest cell Chi-Square value of 106.43 is in the cell of EU export-innovative. That is because the number of observed cases has been much greater than is expected (Observed = 35, Expected = 7.24).

Table 6. Total number of enterprises that sold goods and/or services according to the turnover view of the largest geographical markets

The presence or absence of innovation	Geographic markets Export/overseas			
	Local/regional level in Armenia	National level (in other marzes of Armenia)	EU or associated countries	Other countries
Innovative	127	54	35	22
Not innovative	1788	350	42	113

Sources: developed by the author based on (ARMSTAT, 2017).

Based on table 6 data Chi-square test has been applied. The results are presented in table 7.

Table 7. Chi-square test for association results

Chi-square	df	p-value
149.72	3	2.2e-16

Sources: developed by the author using R programming language.

Table 8. Cell expected values and (cell Chi-square values)

The presence or absence of innovation	Geographic markets Export/overseas			
	Local/regional level in Armenia	National level (in other marzes of Armenia)	EU or associated countries	Other countries
Innovative	180.0751 (15.64)	37.98973 (6.75)	7.240616 (106.43)	12.69459 (6.82)
Not innovative	1734.9249 (1.62)	366.01027 (0.70)	69.759384 (11.05)	122.30541 (0.71)

Sources: developed by the author using R programming language.

It means that a significantly higher number of EU exporting companies have made innovations than would be expected if there would be no association between innovation and sales' geographic location. The second largest is the Innovative-Local market cell with a Chi-Square value of 15.64. That is the result of the observed value being 127, while 180.0751 was expected. It means that the companies who sell their goods/services in the local/regional market have done significantly fewer innovations than could expect. The third-largest cell is the Not innovative-EU export cell with the Chi-Square value of 11.05. That is the result of the observed value being 42, while 69.75 is expected. It means that the number of companies doing export to the EU which has not to make innovations are less than it is expected if there is no association. The fourth-largest cell is the Innovative-Other countries cell, with the Chi-Square value of 6.82. It is because the number of observed cases is much more significant than is expected.

So, the inference is that the companies that export are more innovative (*ceteris paribus*), and the most innovative companies are EU export companies. Or the more innovative companies are more prone to do the export. Of course, causality analysis is needed to understand the cause-effect relationships. The obtained results testify to the clear association between innovation and export. As export shows a country's ability to produce and trade in the international market, some scholars use export as a proxy of international competitiveness. Therefore, the conclusion from the obtained results is an association between innovation and international competitiveness, which is consistent with the theory.

Conclusions. To sum up, the paper investigates the innovative performance of Armenian legal entities and enterprises using firm-level data. For that reason, the research discusses whether the firm size matters to the enterprise's innovative activity. The results of the Wilcoxon test showed that the size of a company does not matter, and companies do innovations regardless of their size. The paper also

discusses whether the innovative activity is different in different NACE groups' enterprises. The ANOVA test and Tukey test results showed that enterprises in some fields of the economy are more prone to innovate than others. Thus, when considering a company's innovative activity, the sphere of the economy in which it operates has statistically significant importance in contrast with the company's size. The last question discussed in this study is whether sales market geographic location is associated with an enterprise's innovative activity. The Chi-square results show that a significantly higher number of EU exporting companies have made innovations than could be expected if there would be no association. The results also show that the companies selling their products/services in the local market have made significantly fewer innovations than expected if there would be no association between innovations and sales market geographic location. In other words, the companies which do export are more innovative than the companies which sell their products in the local market, and the most innovative firms are EU exporting enterprises. The export is usually used as a proxy of international competitiveness due to its ability to show a country's capacity to produce and sell in the international market. Therefore, it could be stated that based on Armenian firm-level data, there is an association between them innovation and international competitiveness. Further studies should concentrate on finding the causality between innovation and export. That would allow policymakers to go in the right direction in contributing to the enhancement of international competitiveness.

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Рузанна Тадевосян, Вірменський державний економічний університет, Республіка Вірменія

Ключові детермінанти ефективності інноваційної діяльності компанії: приклад Вірменії

У статті систематизовано аргументи та контраргументи щодо взаємозв'язку між розміром підприємства, географічним розташуванням ринку збуту та його інноваційною діяльністю. Головною метою дослідження є емпірична перевірка теоретичних тверджень щодо взаємозв'язку між розміром підприємства, експортною та інноваційною діяльністю. У роботі сформувано наступні дослідницькі питання: 1) Чи впливає розмір підприємства на його інноваційну діяльність?; 2) Чи існує різниця в інноваційній діяльності підприємства відповідно до Європейського класифікатора видів економічної діяльності?; 3) Чи впливає географічне розташування ринку збуту на інноваційну діяльність компанії? Підґрунтям дослідження стали дані вірменських підприємств. Для аналізу даних використано критерій Уїкоксона, дисперсійний аналіз ANOVA, критерій Тьюкі та критерій χ^2 . За результатами дослідження встановлено, що розмір підприємства не впливає на інноваційну діяльність підприємства. Автором наголошено, що попри переваги у ресурсозабезпеченості великих підприємств, малі підприємства є більш гнучкими та мобільними у впровадженні інновацій. Таким чином, розмір підприємства не є обмежувальним фактором. У дослідженні емпірично підтверджено, що галузь економіки, в якій функціонує підприємство, має статистично значуще значення в його інноваційній діяльності. Автором встановлено, що більшість інноваційних підприємств Вірменії представлені у групі М-Професіонали, науково-технічній діяльності та групі С-Виробництво. За результатами тесту χ^2 встановлено, що підприємства, які експортують продукцію до ЄС є більш інноваційними. При цьому підприємства, які функціонують на місцевому ринку, мають значно нижчий рівень інноваційності, ніж очікувалося у випадку відсутності зв'язку між інноваціями та географічним розташуванням ринків збуту. У рамках дослідження експорт розглядається як показник міжнародної конкурентоспроможності, який демонструє спроможність країни поставляти продукцію на міжнародний ринок. Таким чином, за емпіричними результатами дослідження встановлено зв'язок між інноваціями та рівнем міжнародної конкурентоспроможності. Результати дослідження мають практичне значення і можуть бути прийняті до впровадження переважно в мікроекономічному середовищі Вірменії.

Ключові слова: конкурентоспроможність, діяльність підприємства, розмір підприємства, експорт, інноваційний потенціал.